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14. ABSTRACT An acoustical assessment was performed on the Combat Arms Firing Range at Kunsan AB in May 2012. It was determined that the noise in the firing range did not meet the definition of impulse noise in AFOSH Standard 48-20 due to acoustical reflections, particularly off the side walls. Therefore, it was recommended that acoustical absorption be added to these side walls to reduce the reverberant field.					
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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

7 May 2013

MEMORANDUM FOR 8 MDOS/SGOJ

ATTN: MAJ MICHAEL SMITH
UNIT 2102
APO AP 96264

FROM: USAFSAM/OEC

2510 Fifth Street

Wright-Patterson AFB OH 45433-7913

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0008, Acoustical Assessment of Firing Range, Kunsan AB, South Korea

1. INTRODUCTION:

a. On 30-31 May 2012, the United States Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC) and USAFSAM Detachment 3 (DET 3-USAFSAM/CD), at the request of 8 MDG/SGOJ, performed an acoustical assessment of the Combat Arms Training and Maintenance (CATM) firing range facilities at Kunsan AB, South Korea. Upon completion of the assessment, the noise at the CATM range was classified as continuous as opposed to impulse noise. The purpose of this letter is to show the significance of this continuous noise classification as it pertains to noncompliance with AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*. The need for acoustical treatment is required to alter the noise classification from continuous to impulse noise.

b. *Survey Personnel:*

- (1) Chief, Occupational Health Services, DET 3-USAFSAM/CD
- (2) Flight Chief, Consultation Division, DET 3-USAFSAM/CD
- (3) Consultant, Industrial Hygiene Technician, USAFSAM/OECM
- (4) Senior Noise Engineer, USAFSAM/OECC

c. *Personnel Contacted:*

- (1) Bioenvironmental Engineer, 8 MDG/SGOJ
- (2) Combat Arms Training Instructor, 8 SFS/S30

d. *Equipment:*

- (1) B&K PULSE Analyzer, Type 3560-B-140, SN 2588445
- (2) Larson Davis Microphone Power Supply, Model # 2221, SN 0207
- (3) Larson Davis Preamplifier, Model # 902, SN 3824
- (4) Larson Davis Microphone, Model # 2530, SN 1483
- (5) Quest Calibrator, Model # QC-20, SN QF8050050

2. BACKGROUND:

a. The Kunsan AB CATM range is a partially contained range with seven total firing stations (see Figure 1). The range is used for M4 and M9 training. A noise-reverberant field occurs during firing where the noise energy is reflected off the ceiling, walls, and floor surfaces, thereby increasing noise levels for a longer duration. These noise levels diminish slowly compared to noise levels in free field conditions (i.e., outdoors or indoors with acoustical absorption on the interior surfaces). Down range of the firing line is a series of steel safety baffles on the ceiling that are designed to deflect stray bullets and prevent bullets from leaving the range. These panels are closely spaced and reflect acoustical energy, contributing to the increased duration of noise levels.



Figure 1. Kunsan CATM Range Lanes 1-7

b. The nonlinear acoustical effects of the gunfire peak noise, double hearing protection, and short-term residual auditory effects from gunfire make it very difficult for students and instructors to communicate. Communication difficulties include understanding instructions and warning signals. To compensate for the multiple noise sources, the volume of the control tower speaker system is fixed at a high level. When hearing protection is not worn (i.e., providing/receiving group instruction), the students are exposed to high levels of noise from the speakers.

c. The maximum level of **continuous noise** that is allowed to reach the ear shall not exceed 115 dBA, and the maximum level of **impulse noise** that is allowed to reach the ear shall not exceed 140 dB peak SPL, in accordance with AFOSH Standard 48-20.

3. METHODS:

a. The SPL time histories corresponding to individual M4 and M9 weapon shots were measured with a 1/4-inch microphone placed 5 feet above the yellow line (the safety line behind which students remain when not shooting); see Figure 2 for microphone position. Time histories are measured SPLs over a duration of approximately 4 seconds. This duration provided sufficient time to completely describe the decay of the acoustical energy to background levels. These time histories were then used to compute acoustical decay characteristics.

b. On the day of the assessment, SPL time history data were collected while one base member first fired an M9 using lane 4 of the range. Data were also collected while the same individual fired an M4 using the same lane. The microphone was positioned behind and to the left of the shooter at the yellow line during the entire assessment.

c. The linear SPL decay rates, in decibels per second, were computed by selecting the linear decay phase of each time history and performing a sound level versus time analysis through the decay phase. The slope of this curve is the decay rate.

d. Decay times, in seconds, were computed based on the decay rate by calculating the duration of time required for the SPL to decay from 150 dB down to 80 dB, due to the fact that noise decay above 150 dB is nonlinear.

4. RESULTS:

a. The noise decay at the Kunsan AB CATM range **does not** meet the definition of impulse noise in accordance with AFOSH Standard 48-20. The definition states that impulse noise is “a short burst of acoustic energy consisting of either a single burst or a series of bursts. The pressure-time history of a single burst includes a rapid rise to a peak pressure followed by a somewhat lower decay of the pressure envelope to ambient pressure, both occurring **within 1.0 second**. A series of impulses may last longer than 1.0 second.”

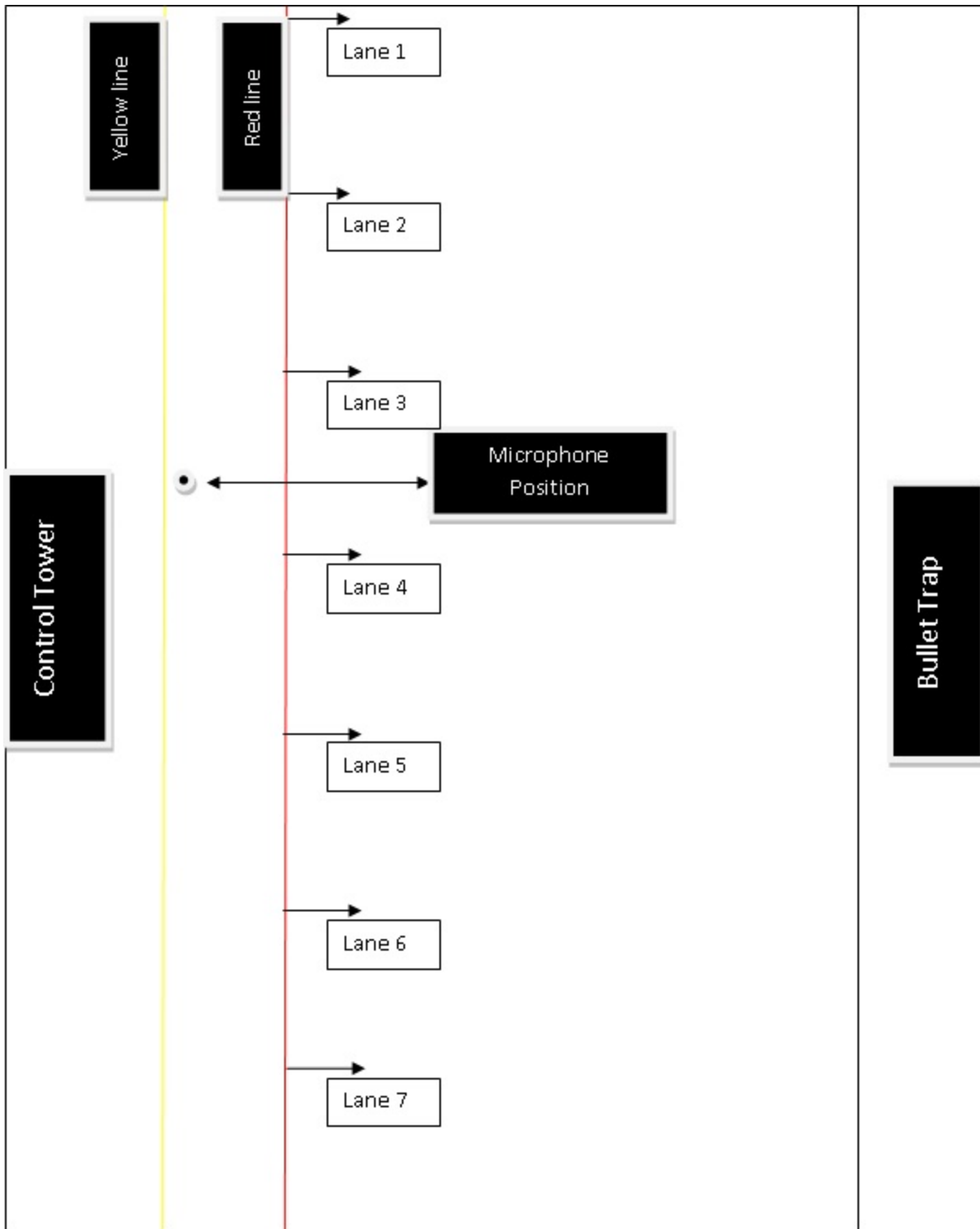


Figure 2. Kunsan CATM Range Layout and Microphone Position

b. The decay time, when averaged over multiple shots and two different types of weapons, was **1.6 - 1.7 seconds**. See Table 1 for a summary of noise characterization and decay times.

Table 1. Noise Characterization by Decay Time

Weapon System	Noise Level* (dB)	Average Decay Time (s)	Noise Characterization	Maximum Continuous Noise Level (dB)	Exceeds Continuous Noise Std. (Yes/No)
M4	123	1.7	Continuous	115	YES
M9	123	1.6	Continuous	115	YES

*Noise level with double hearing protection providing 33 dB of attenuation.

5. CONCLUSIONS:

a. Based on the average decay times, the noise in the range is not impulse noise; the noise is continuous noise. Thus, the hazardous noise does not meet the regulatory definition of impulse noise. Based on the continuous noise standard, there is no allowed exposure time above 115 dBA.

b. Speech intelligibility is poor due to the strong reverberant sound field of the range. This condition increases safety risks.

6. RECOMMENDATIONS:

a. Until effective engineering controls can be implemented, consider close scrutiny to audiograms, as defined in Attachment 1 of AFOSH Standard 48-20, for CATM instructors, as they **are not** adequately protected in the current range configuration with personal protective equipment and administrative controls.

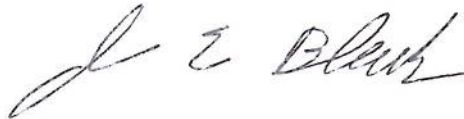
b. **Install sound-absorbing material to reduce the reverberant field.** The reverberant field in the range should be minimized to reduce the noise level to protect instructors and students from hazardous noise exposure and to improve speech intelligibility.

c. Treat the firing area's first overhead baffle, as well as the ceiling and walls from the red line back, to include the rear wall, with acoustical absorption material. Quilted fiberglass, or other fiberglass panels wrapped in a manor allowing easy cleaning, is one option. There are also more fixed installation materials available, such as products offered by Pyrok or Troy Acoustics. There appears to be a previous attempt at installing sound-absorbing materials on the walls from the red line back. This material should not be removed if additional sound-absorbing materials are installed.

d. **Adjust the speaker system volume for weapons discharge or instructor lecturing. Additionally, ensure CATM instructors provide just-in-time training to students on proper use of hearing protection devices as part of classroom instruction.** NIOSH has a short video on proper insertion of foam ear plugs available for download at:
<http://www.cdc.gov/niosh/mining/products/movies/rphhi.wmv>.

e. **Perform a follow-up assessment after acoustical treatment of the range is complete.** The assessment would determine overall effectiveness and evaluate the type of noise—impulse noise versus continuous noise.

7. If you have any further questions regarding this report, please contact Mr. Andrew Wells at DSN 798-3306 or andrew.wells@us.af.mil. Please direct any questions or comments regarding Industrial Hygiene Consultative support to Lt Col Sonntag at DSN 798-3328 or david.sonntag@us.af.mil. To improve our services, please complete and return the critique provided with this report.

A handwritten signature in black ink, appearing to read "J E Black".

JON E. BLACK, Maj, USAF, BSC
Chief, Bioenvironmental Engineering Consulting Branch